NASAfacts

Space Technology

Game Changing Development

OuroboroSat: A Modular, CubeSat-Scale Instrumentation Platform

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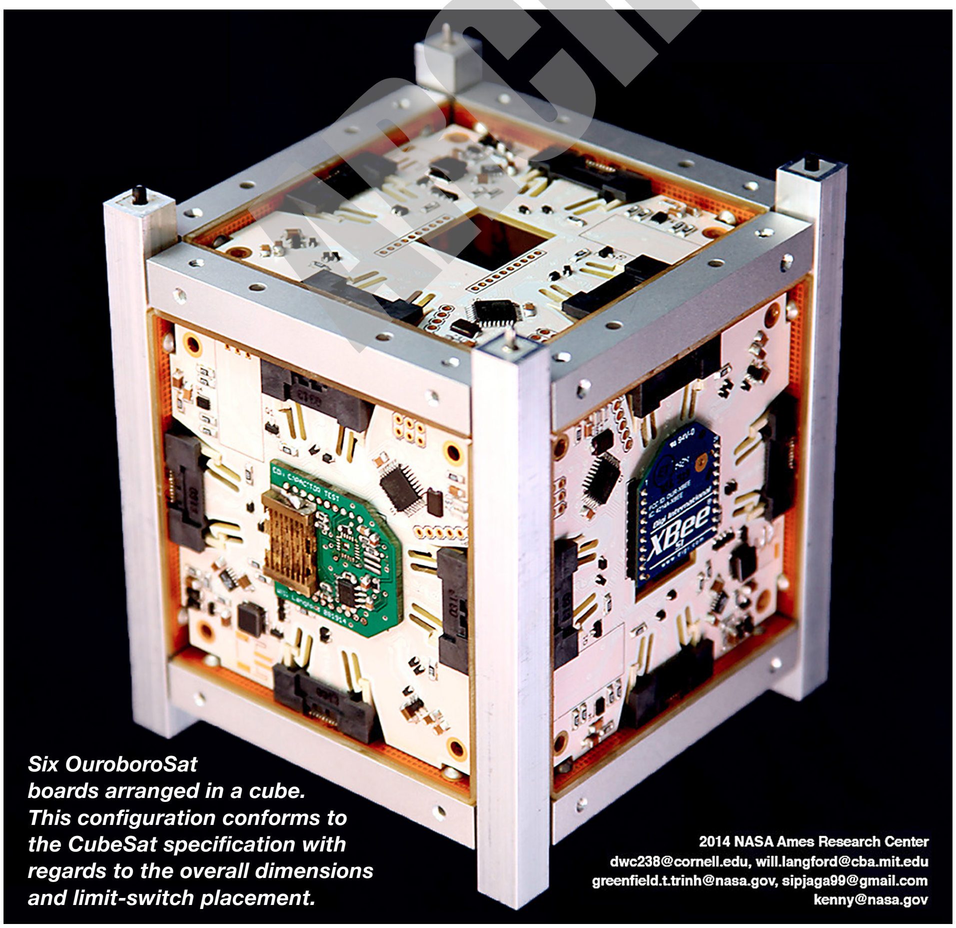
OuroboroSat, also known as the Modular Rapidly Manufactured Spacecraft System (MRMSS), is a modular instrumentation platform consisting of multiple 3 inch (7.5 centimeter) square printed circuit boards that are mechanically and electrically connected to one another in order to produce a fully functioning payload facility system. Each OuroboroSat module consists of a microcontroller, a battery, conditioning and monitoring circuitry for the battery, optional space for solar panels, and an expansion area where an experimental payload or specialized functionality (such as wireless communication submodules) can be attached.

A typical OuroboroSat mission involves many modules connected together, each of which can host an experimental payload. The microcontroller on each board communicates with the experimental payload, packages the received information, and sends the data to a dedicated OuroboroSat board with a communication



Six OuroboroSat boards arranged in a cube. This configuration conforms to the CubeSat specification with regards to the overall dimensions and limit-switch placement.

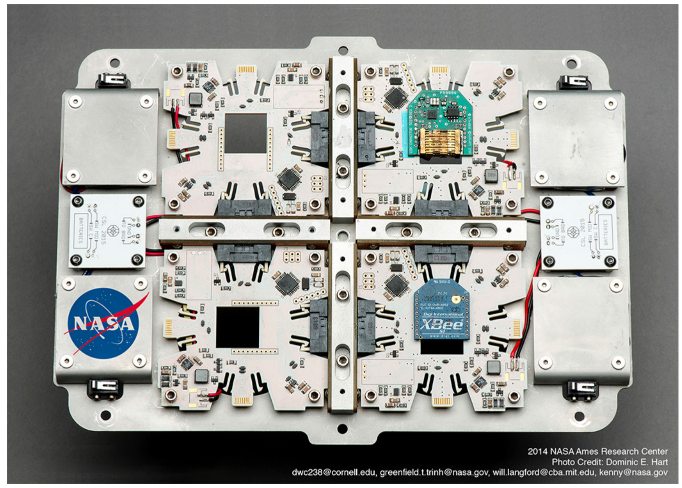
2014 NASA Ames Research Center
dwc238@cornell.edu, will.langford@cba.mit.edu
greenfield.t.trinh@nasa.gov, sipjaga99@gmail.com
kenny@nasa.gov

submodule to relay back to the ground. In addition to allowing data to be transferred from one module to another, the OuroboroSat modules can also enter a mode where one board can transfer power to another. In this way, boards with resource-intensive payloads or those in eclipse can request power from their neighbors in order to continue functionality.

The core components of an OuroboroSat module can be produced on a breadboard for less than $100, enabling initial prototyping and integration of scientific payloads with near-negligible investment. The board designs are available online at no cost and are modeled in software available as a freeware version. The microcontroller uses the Atmel AVR toolchain with an Arduino bootloader, which has extensive documentation and support. Taken together, this platform promises to further reduce spacecraft costs by removing the required investment in platform development testing and significantly reducing integration cost. Furthermore, the use of a common platform that is available open-source will allow multiple parties to more easily aggregate efforts into a single launch, further reducing the barrier of entry into space.

The initial flight-test of the OuroboroSat system occurred as an element of the Sub-orbital Aerodynamic Re-entry Experiments (SOAREX-8) Exo-Brake experiment, that was launched from NASA's Wallops Flight Facility on July 7, 2015. For this experiment, four OuroboroSat boards were configured in a two-dimensional array, in order to fit the 0.5 inch (1.27 centimeter) vertical clearance shown in the image on the front. The components used in this configuration were identical to those shown in the image above right, which illustrates the flexibility that the system allows in providing a consistent platform regardless of the external constraints on volume and area.

The sounding rocket test article included two specialized payloads, one containing a digital materials experiment developed by Will Langford at the MIT Center for Bits and Atoms, and the other containing an xBee wireless communication module that transmitted data back to the SOAREX-8 experiment for transmission to the ground. The flight successfully validated the ability of multiple specialized OuroboroSat modules to act in tandem to behave as an instrumentation platform. These capabilities include: interboard communication and multiboard



The OuroboroSat boards in the sounding rocket configuration. In order to conform to the low vertical clearance, the boards were arranged in a 2D array.

routing, successful hosting an independently-developed experimental payload, and the successful relay of data collected from the payload over the xBee's 802.15.4 wireless protocol.

Future experiments will characterize the ability of the modules to perform power sharing in the operational environment, and will expand the scale to explore the efficiency of the communication system for large numbers (>10) of modules.

The Game Changing Development (GCD) Program investigates ideas and approaches that could solve significant technological problems and revolutionize future space endeavors. GCD projects develop technologies through component and subsystem testing on Earth to prepare them for future use in space. GCD is part of NASA's Space Technology Mission Directorate.

For more information about GCD, please visit
http://gameon.nasa.gov/
For more information about OuroboroSat, contact:

Daniel Cellucci
Graduate Student, Space Systems Design Studio
Cornell University
daniel.w.cellucci@nasa.gov
Kenneth C. Cheung
Principal Investigator, Coded Structures Lab
Ames Research Center
kenny@nasa.gov

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National Aeronautics and Space Administration

Ames Research Center
Moffett Field, CA 94035

www.nasa.gov

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